REMOTE STORAGE

STATEMENT OF EVIDENCE

SUBMITTED BY

THE SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH

TO THE

LOW GRADE MINES COMMISSION.

AUGUST, 1919.

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THE SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH,

JOHANNESBURG.

230222

August 12, 1919.

To—

The Chairman and Members,
Low Grade Mines Commission,
New Law Courts,
Johannesburg.

GENTLEMEN,

You have asked for a statement from the South African Institute for Medical Research on any of the points contained in the terms of reference of your Commission, but more particularly with regard to the prevalence of Pneumonia amongst mine Natives, especially amongst " Tropical Boys " from North of latitude 22° S.

The only matter specified in your terms of reference upon which, as Director of the Institute, I have any particular qualification to express an opinion is the steps which might be taken by the Government to obviate the closing down of any or all of the mines now working at a loss. Of such steps the only one concerning which my opinion can be of any value is that of re-introducting tropical labour—a procedure which, as one understands from the statements in the daily Press, is one of the schemes proposed to combat the threatened economic and industrial depression. It is obvious that the only aspect of this proposal with which I may legitimately concern myself is that of the health of the prospective labourers.

DIRECT
OCT 30

Although, for the reasons stated, the range of my remarks must be very restricted, the field which is left for one to cover is nevertheless very extensive. My experience has gradually led me to the conviction that Natives from tropical latitudes, or any other people who are specially liable to contract Pneumonia,* can be almost completely protected against this disease by the inoculation of a bacterial vaccine, prepared in accordance with the results, and modified when necessary in accordance with the progress, of recent research. Experience, however, has taught one even more than this, for it has now been abundantly demonstrated that, at least as far as mine labourers are concerned, the systematic employment of such a vaccine reduces not only the mortality from Pneumonia but also that from " other diseases."

I propose to deal with this subject in three Chapters, and to conclude with a brief series of apparently unco-ordinated observations which are intended to anticipate questions of various kinds. A table of References to available literature will be added.

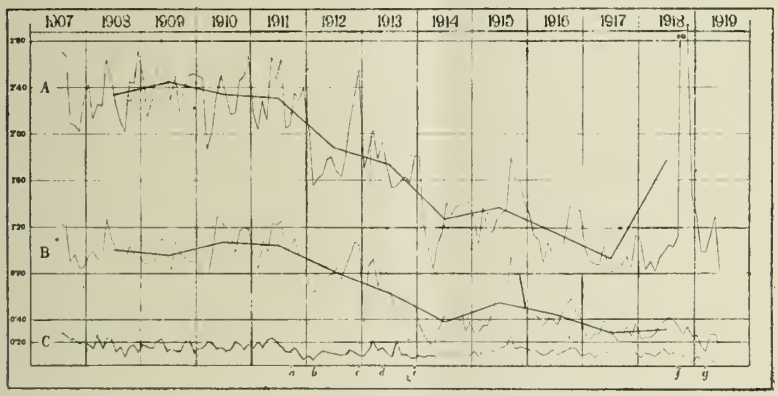
* The term " Pneumonia " is intended, throughout this statement, to refer to Primary Lobar Pneumonia.

(I).

EVIDENCE AFFORDED BY THE COURSE OF THE GENERAL MORTALITY FROM DISEASE AMONGST MINE LABOURERS.

For several years past I have transferred the monthly mortality returns relating to the Natives employed on Mines and Works in the Proclaimed Labour Districts of the Transvaal to a chart, and a copy of this chart (Chart I.) is now submitted for your consideration. The data from which this chart has been gradually constructed have been courteously supplied, month by month, by the Native Affairs Department.

CHART I.



MONTHLY DEATH-RATES (PER 1,000 EMPLOYED) AMONGST NATIVE LABOURERS ON MINES AND WORKS IN THE PROCLAIMED LABOUR DISTRICTS OF THE TRANSVAAL FROM—

A. All Diseases.

B. Pneumonia.

C. Meningitis.

NOTES.

(*a*) Sir Almroth Wright arrived, September 30, 1911.
(*b*) Sir Almroth Wright left, February 28, 1912.
(*c*) Dr. Parry Morgan left, December, 1912.
(*d*) Recruiting of Tropical Natives ceased, May, 1913.
(*e*) Colonel Gorgas visited Rand, December, 1913.
(*f*) Epidemic Influenza first recognised on Mines, September 22, 1918.
(*g*) Recrudescence of Epidemic Influenza, April, 1919.

There are three series of records on this chart—the topmost curve (A) represents the monthly death-rate from all diseases, whilst superimposed upon it is a bolder line indicating the mean monthly rate for the year; the middle curve (B) is that of the monthly death-rate from Pneumonia, the mean of the monthly rates being again indicated by a bolder line; the lowest curve (C) refers to the proportional mortality from Meningitis.

It will be noticed that the death-rate from all diseases remained uniformly high during the first four years (1908-11). The average of the annual rates for this period was 28·32 per thousand employed. There is good reason for believing that in the years antecedent to 1908 the death-rate was never materially lower than this figure, and was often considerably above it. In the year 1912 a very marked fall in the death-rate was recorded, and it is obvious that this decline has been consistently maintained ever since—excepting for a slight retrogression in 1915, to which reference will again be made, and a marked rise in 1918, coinciding with and consequent upon the visitation of Epidemic Influenza.

The agencies which brought about the improvement in 1912, and which have, to judge from our chart, been in more or less continuous operation ever since, have resulted in the saving of the lives of approximately 15,000 Native Labourers duing the six years, 1912-17, the year 1918 being deliberately ignored owing to the Influenza epidemic; in other words, if the high death-rate (28·52) of the four years antecedent to 1912 had been continued, some 15,000 more Natives would have died in this period alone.

The height above the base line of the middle curve, that for Pneumonia, indicates the large share that this disease has contributed to the general mortality; reference to the monthly returns of the Native Labour Department shows, in fact, that during the ten years, 1908-17, it accounted for 40 per cent. of the total mortality from disease. That the reduction of the general death-rate has been largely due to a reduction of the death-rate from Pneumonia is apparent fom the chart, but what is not immediately apparent is that the beneficial agencies. whatever they have been, have had *a specific influence* upon the Pneumonia mortality. I base this deduction upon the fact that, whereas the Pneumonia mortality represented 43 per cent. of the general mortality in the four years, 1908-11, it represented only 36 per cent. of the mortality in the six subsequent years.

It was in the last quarter of the year 1911 that the work of scientifically combating the Pneumonia of our Native Labourers was initiated by the visit of Sir Almroth Wright, and the only preventive procedure which was then adopted and which has been carried out with increasing method and extent ever since that time has been prophylactic inoculation with pneumococcal vaccine.

Anti-pneumonia inocluations were begun upon the 4th of October, 1911, and were at first carried out with a pneumococcal vaccine

which had been prepared in London for this particular purpose. The work of Sir Almroth Wright and his Associates is detailed in Part II of his Report to the Witwatersand Native Labour Association.[1] It consisted of six " mass-experiments," or experimental inoculations of large bodies of Natives, the first five of which, it is stated, were carried out upon Tropical Natives alone. The dates and extent of these collective experimental inoculations were as follows:— (1) October 4, 1911—April, 1912, 5,963 (Tropical Natives). (2) December, 1911—January, 1912, between 20,000 and 30,000 (? Tropical Natives). (3) May, 1912, about 3,975 Tropical Natives. (4) November, 1912, 2,322 Tropical Natives. (5) August—November, 1912, probably about 2,000 Tropical Natives. (6) January—March, 1912, over 4,000 Native Labourers, of non-tropical origin, employed at the Premier Mine.

From the foregoing it is apparent that between October, 1911, and November, 1912, some 39,000 inoculations had been administered to, as it is alleged, Tropical Native Labourers. Sir Almroth Wright's Report admits that many of these Natives were re-inoculated and included in more than one experiment, and that many of the uninoculated " controls " in one experiment became inoculated units in subsequent experiments—procedures which must have seriously embarrassed, if they did not entirely prevent, any simple and unequivocal record of the results. As there was a total of about 20,000 Tropical Natives on the Rand in 1912, it seems reasonable to suppose that the majority of them were inoculated with Sir Almroth Wright's vaccine. The marked fall in the total mortality from all diseases which took place in 1912 can, in my opinion, be reasonably attributed to no other agency than the use of this vaccine among the Tropical Natives; Sir Almroth Wright himself claims that the death-rate from Pneumonia amongst them was reduced by from 30 to 50 per cent.. That the obvious effect on the general mortality curve was not greater is doubtless due to the fact that the Tropical labourers constituted less than one-tenth of the total labour force; that it was as marked as it is, is probably because the Tropical labourers were far more susceptible to Pneumonia than other Natives.

In discussing this chart of the mortality from all diseases it must be remembered that it does not represent the mortality amongst inoculated Natives, nor that amongst Tropical Natives, but the death-rate amongst *all* the Native labourers of the mines and works of the Transvaal.

A fact which is illustrated by this chart is one of such significance to the objects of the present enquiry that special attention should be invited to it. The rapid decline in the general mortality which has marked the years since 1911 had obviously set in some fifteen months before the recruiting of Tropical Natives ceased, in May of 1913, by command of the Legislature. A little more faith in the utility of Medical Research would doubtless have prompted delay before resorting to this drastic prohibition.

Sir Almroth Wright left the Rand at the end of February, 1912, and the work which he had started was continued by Dr. W. Parry Morgan until December of the same year. The issue of " Wright's " pneumococcal vaccine was maintained during this year by Dr. Parry Morgan, and, upon his departure, was carried on by the Institute until a few months after the outbreak of the war, in 1914. From June to October, 1914, however, several thousands of doses of Dr. Lister's " 5-group vaccine " were issued, and from the middle of 1915 onwards the Institute has supplied the mines with Lister's " specific group vaccine " only. In July, 1918, the " 5-group " was replaced by an " 8-group " vaccine.

It is of more than mere interest to record the annual amounts of pneumococcal vaccine used by, or issued for use to, the Industry, since 1911; they were as follows:—

1911 about	17,609.	1915	28,745.
1912 about	60,655.	1916	149,685.
1913	170,896.	1917	128,820.
1914	112,698.	1918	308,744.

1919 (to May) 255,850.

The total is approximately 1,234,000, of which the Institute has prepared and issued 1,156,000. It is significant that the year 1915, in which a relatively very small amount of vaccine was issued, is the only year (with the exception of the Influenza year) in which the downward march of the general mortality shows a definite retrogression. That this exceptional year was not characterised by any relaxation of general hygienic measures may be safely assumed, and one is therefore justified in suggesting that the inimical agency at work was nothing more than the great and sudden decline in prophylactic inoculation consequent upon the war.

Before concluding our somewhat meagre consideration of this chart, attention may be drawn to one or two of the many other points which it serves to illustrate—

The monthly Pneumonia death-rate reached its lowest point ever recorded (0.12) in March of the present year. In addition to the marked lowering of the mortality from Pneumonia during recent years the former tendency of the death-rate line to exhibit violent oscillations—which are in fact due to the occurrence of miniature epidemics—is evidently becoming suppressed; to illustrate this a comparison is invited of the Pneumonia curve during the year 1910 and 1911, and the same curve during the years 1917 and 1918. Our experience has taught us that epidemics of Pneumonia are due to an abundance of infections from one or other of the common groups of Pneumococci, and it may be reasonably surmised that such epidemics will be no longer possible in communities which have been systematically immunised against these groups.

The mortality from Pneumonia in England and Wales is always higher in the months November-April, that is in the cold months, than

during the rest of the year, and usually reaches its maximum in December. Statements as to the seasonal relations of the disease amongst the mine Natives have often been made, but such a chart as we are now considering visualises in an unequivocal manner, at least with respect to the calendar, the distribution of the mortality from the disease since the year 1907. From the chart we see that the Pneumonia mortality was relatively high, in 1907, in July and August; 1908, in May; 1909, in May and again in August; 1910, in May, and again in *October, November* and *December;* 1911, May, June, and July; 1912, *November* and *December;* 1913, in *February* and *March*, and again in May; 1914, July, August, September and *October;* 1915, in June, and again in September, *October* and *November;* 1916, in *October;* 1917, in May; and 1918, in July. The months usually included in the summer months (October to March) in the foregoing are in *italics.* Such irregularity in distribution shows that a seasonal exacerbation is not constant in occurrence, and that a seasonal prevalence of Pneumonia is therefore not a constant phenomenon with regard to the Native labourers. Dry and windy weather is, for theoretical reasons, likely to conduce to the occurrence of Pneumonia: that such weather has actually been associated with an increase in the disease has, I understand, been pointed out by Dr. A. J. Orenstein.

Owing to the fact that the Pneumococcus is responsible, on the Rand, for a considerable proportion of the total cases of Meningitis—about 35 per cent. of all cases when the infection is due to only one kind of organism—a close correlation between the mortality from Meningitis and that from Pneumonia is often to be observed; specific protection against pneumococcal infections by inoculations has a definite and beneficial influence upon the mortality from Meningitis. The monthly mortality from Meningitis was as low in May of this year (0.03) as it has ever been; on only one previous occasion has it been so satisfactory, namely, in December of 1918.

The general death-rate from disease for the last month for which we have received returns (June of this year) was never more favourable; it has only reached so low a point (0.81) on two occasions previously—April, 1918, and July, 1917.

The *annual* death-rate from all diseases fell to the lowest point hitherto recorded, viz., 11.04, in 1917. This rate is actually lower than that amongst males in any of the County Boroughs of England and Wales during the year 1913; in drawing attention to this fact, however, it should be pointed out that our Native labour population is mainly composed of men between the ages of 20 and 30, and that in such an age-period death is far less common than at the extremes of life. It may be anticipated with certainty that, excluding unforeseen epidemics of other diseases, the annual death-rate from disease amongst the mine labourers will be still further reduced in the near future. During the last six or seven years this death-rate has been reduced by considerably more than half, and it may be safely surmised that, with a continuance of the same beneficial activities, the decline will be continued.

(II).

LABORATORY EVIDENCE.

To Sir Almroth Wright will always belong the credit of having introduced on the Rand the method of protecting against Pneumonia by means of inoculating with a pneumococcal vaccine. The experiment was made at a time when but little of material importance had been discovered about the Pneumonia-producing germ, and subsequently acquired knowledge has enabled us to improve greatly upon the vaccine then used. To Dr. F. S. Lister the whole of humanity is indebted for (1) brilliant discoveries as to the existence of several totally distinct groups of the Pneumonia-producing germ, and the necessity for very greatly increasing the strength of the vaccine if the presence of the immunity is to be detectable in the blood, and (2) for the practical application which he has made of these discoveries in the devising of an effectively immunising vaccine. I have no doubt that Dr. Lister's name will always be honourably associated with his successful investigations into the cause and prevention of Pneumonia.

Dr. A. J. Orenstein's evidence before this Commission suggests that Dr. Lister's discoveries of distinct groups of Pneumococci was assisted by the work which was being carried out at the Rockefeller Institute. This is not quite a fair statement, for I received from Dr. Lister his manuscript of our " Publication No. III " (" Specific Serological Reactions with Pneumococci ") before I communicated to him the announcement of the American discoveries which I had received a few days previously.

The existence of distinct groups of Pneumococci has now been indubitably confirmed in other parts of the world, and all recent progress in our knowledge of the cause and prevention of Pneumonia has been consequent upon this discovery. Apart from prophylactic inoculation, one need only instance the advances which have been made in the epidemiology of the disease and in the treatment of it with specific serum.

It would be appropriate here to refer to the fact that in his work at the Institute Dr. Lister has never found any other organism than the Pneumococcus in the lungs of pneumonia patients. It may be explained that in every instance his specimens were derived either from a puncture of the inflamed lung, or from the blood of the patient, during life. As far as the Primary Lobar Pneumonia of our Natives is concerned, it may be therefore safely asserted that the Pneumococcus is the cause of practically all the infections. This observation is in substantial agreement with that of Sir Almroth Wright [1]; and that the Pneumococcus is mainly responsible for Pneumonia in other parts

of the world also is demonstrated by the researches of the workers at the Rockefeller Institute [6] and, still more recently, by the observations of Dr. G. H. Burnell [7], of New South Wales.

To the scientific mind no argument is more cogent than the results of properly devised experiments, and such experiments constitute one of the foundation-stones of our confidence of being able to produce an immunity against Pneumonia. In "Publication No. VIII" of the Institute [4] Dr. Lister describes how all of six rabbits which had been previously thrice inoculated with pneumococcal vaccine were quite unaffected by a dose of living virulent Pneumonia germs eight times larger than that sufficient to kill each and all of six un-immunised animals.

The presence of protective substances (antibodies) in the blood-serum of suitably inoculated individuals can be detected by laboratory methods; and, moreover, three or four drops of the blood-serum of such an inoculated person will regularly prevent the death of a mouse (the most susceptible of all animals to the Pneumococcus) which has received one hundred times a fatal dose of the living Pneumonia germ. It is perhaps necessary to state that the blood-serum of an un-inoculated person possesses no protective power whatever.

If so small a quantity of the blood-serum of an inoculated human being will protect so susceptible a creature as a mouse from an otherwise utterly overwhelming pneumococcal infection, it is but reasonable to suppose that the inoculated man himself, be he from the tropics or the temperate zones, will successfully resist the natural and less severe method of infection.

The foregoing observations are but a small part of a mass of experimental evidence; they will, however, serve to illustrate the salient points of the question.

(III).

EVIDENCE FROM THE RESULTS OF PROPHYLACTIC INOCULATION ON INDIVIDUAL MINES AND IN OTHER PARTS OF THE WORLD.

The practical results obtained upon the Premier, and the Crown Mines, by the use of a vaccine containing only three groups of the Pneumococcus, and on the De Beer's Mines by one containing four, are detailed in " Publication No. X." of the Institute [5]. The mortality from all diseases, and from Pneumonia, on these mines has been recorded upon charts which I hope to be able to submit for your information. (Charts II., III., and IV.). The principal reasons why these mines have been alone selected for immunisation with vaccine were that Pneumonia had been specially rife upon all three, and that in consequence of their large populations the annual mortality had been excessive.

It has been pointed out, I understand, in evidence before this Commission that on some mines which have not adopted inoculation Pneumonia has been relatively less prevalent than on others where the Natives have been well-inoculated. This phenomenon is dealt with on p. 7 of " Publication No. X." of the Institute [5], to which reference should be made. It should also be remarked that the general type of labourer varies on different mines; those mines which attract " voluntary boys "—who are, for the most part, " old hands," and as such are notoriously less liable to Pneumonia—may be expected to show a lower Pneumonia incidence than those mines more dependent upon raw, recruited labour. It is noteworthy that the chart for the Premier Mine mortality(Chart II.) indicates that since the systematic use of Lister's vaccine (November, 1916) there have been eight separate months in which no deaths from any disease occurred, viz., February, March, October, and November, 1917, April, 1918, and January, February, and April, 1919. Such events are entirely unprecedented in the history of the mine.

The chart of the relative mortality on the Crown Mines (Chart III.) shows that the year 1914 was the first to exhibit the marked depression in the mortality which has characterised the returns during subsequent years; it was about the middle of this year (1914) that Lister's specific-group vaccine was first employed on these mines. It may also be observed that since March, 1916, the curve of the Pneumonia fatalities has remained consistently below the 0.5 per 1,000 line; and that in each of six individual months (January, 1917; February and December, 1918; and February, March, and July, 1919) there were no deaths at all from this disease.

The chart representing the course of the mortality-rate amongst the native employees on De Beers mines (Chart IV.) clearly indicates the introduction, in the month of May, 1917, of some beneficial in-

fluence which, despite the visitation of Epidemic Influenza, has markedly affected the Pneumonia death-rate ever since; from May the first, 1917, all new arrivals on these mines have been inoculated with Lister's vaccine. The terrible mortality of 402 per 1,000 in the month of October, 1918, consequent upon the Influenza epidemic, will doubtless not escape attention. This *rate* was considerably inflated owing to the fact that a large number of unaffected labourers were repatriated during the latter part of the month, thus greatly reducing the average daily number of employees with which the mortality had to be compared.

With regard to the results obtained upon the Crown Mines (Chart III.)—In addition to the events grossly illustrated by the chart, other results of far greater scientific value were obtained. A bacteriological investigation of every case of Pneumonia which arose over a period of nine months subsequent to the starting of inoculation showed that no case was due to any of the three groups included in the vaccine; whereas over 60 per cent. of all cases of Pneumonia in uninoculated natives had been previously due to these groups. After all, this fundamental change in group-prevalence as a result of group-inoculation is a test of the effectiveness of the inoculation which is both more delicate and conclusive than any other which is available to us. Since the method was first devised by Dr. Lister it has been adopted by the American Army Authorities in their investigations into Pneumonia, in 1918, at Camp Upton [8] and Camp Wheeler [9].

The results of the inoculation of about 13,000 men at Camp Upton with a group-vaccine amply confirmed the results obtained on the Crown Mines, as described in our " Publication No. X." One of the most recent items of evidence on the subject of protective inoculation against Pneumonia appeared in " War Medicine " for October, 1918. It is here recorded that, of a contingent of 600 Malagasy troops, recently landed in France, 300 were thrice inoculated with a vaccine prepared from the Pneumococcus by which such troops were specially liable to be infected, whilst three hundred were not inoculated. Amongst the inoculated one non-fatal and mild case of Pneumonia occurred, whilst amongst the uninoculated sixteen severe cases with four deaths occurred during the two months over which the observation extended.

Much has been said of the utility of general hygienic measures in the prevention of Pneumonia, but for my part I think it possible that the influence of such measures is overrated. The hygiene of to-day is merely the outcome of the experimental medicine of yesterday. For instance, a Health Administration which sought to suppress an epidemic of Small Pox without recourse to vaccination would be justly censured. So, too, the time cannot be far distant when inoculation with a pneumococcal group-vaccine will be considered the most effective of all hygienic measures in the prevention of Pneumonia. No well-informed person would belittle the value of general hygienic measures in any community; but that, by themselves, they are incapable of combating the Pneumonia scourge the past experience of many mines on the Reef will testify.

(IV).

OBSERVATIONS.

Length of Survival of the Pneumococcus in Sputum.—The actual period for which the germ of Pneumonia will survive in expectorated material (sputum) has been the subject of recent work by E. G. Stillman [10]. He has recovered the organism from the dust of dormitory floors, even when the floors were very clean, with great regularity in about 30 per cent. of the samples examined. This observation points to the fact that the organism can retain its vitality even after the sputum in which it was originally contained has been reduced by desiccation to the form of dust. The South African Institute has been able to successfully transmit living Pneumococci to New York and to Melbourne in fragments of the dried spleens of infected animals. This fact again illustrates the capacity of the germ to survive for long periods when its surroundings are thoroughly dry. These considerations suggest that the observations of Wood, made some years ago [11], as to the survival of the Pneumococcus for only an hour or so will require confirmation and amplification.

The Number of Inoculations requisite to protect against Pneumonia.—When the vaccine is prepared in a saline medium three injections at weekly intervals are desirable. A recent advance, however, consists in substituting an oily medium for the saline, and a vaccine so prepared is termed a "lipovaccine." Among other advantages this lipovaccine enables us to administer a far larger number of bacterial bodies in a single dose without serious inconvenience. A possible outcome of this improvement will be a reduction of the necessary inoculations to two, or perhaps one.

The Immunity conferred by an Attack of Pneumonia.—The prevalent belief that an attack of Pneumonia confers no immunity will probably have to be abandoned in the near future. There is strong evidence, derived from investigations of second attacks of Pneumonia, that the type (or group) of the germ causing the second attack is different from that which caused the first. It is probable that the conclusion to be arrived at before long will be that an attack of Pneumonia does confer a definite immunity against subsequent attacks, but only against subsequent attacks by the same group.

The Groups of Pneumococcus which commonly affect Europeans and Natives.—Pneumonia in Europeans on the Rand is usually due to an infection by the "C" group, whilst the commonest group amongst Native patients is "A," closely followed, however, by "C." Group "A," which is practically confined to Native infections on the Rand, has not hitherto been recognised with certainty in other parts of the world. That tropical Natives would not be found susceptible to any

important new variety is probable from the fact that amongst Natives in the Belgian Congo and Southern Rhodesia the same groups as are found on the Reef appear to prevail. The prevalent groups amongst our Natives are detailed by Dr. Lister in " Publication No. X." of the Institute, and it is there stated that from 60 to 70 per cent. of Native cases of Pneumonia are due to three or four groups. It is true that there may be some groups of disease-producing Pneumococci still to be discovered; this, however, is not a serious consideration since such unknown groups must be very rare or they would have been found before now. The same groups (" B," " C," and " E ") which are so prevalent with us have also been found to be the leading types in the United States and in Germany (Neufeld and Handel).

The General Prevention of Communicable Diseases.—The fact that the Native employees of the mines are fed, housed, and kept under more or less constant medical surveillance renders them a " sheltered community " from the hygienic point of view. Epidemic diseases, which are responsible for so much mortality in unsheltered communities, are objects for the special vigilance of the employers of compounded labour. Thus the occurrence of Small Pox—a disease which is endemic amongst the Natives of the tropical latitudes of Africa—is guarded against by the systematic vaccination of all labourers arriving on the Reef. Epidemics of Enteric Fever are similarly forestalled by early recourse to anti-typhoid vaccine. The South African Institute for Medical Research issues annually, to the mines alone, about 10,000 doses of anti-typhoid vaccine; the total issues for this particular purpose, since March, 1915, has been 49,800. The annual death-rates from Enteric Fever amongst the Native Labourers of the Mines and Works of the Transvaal, since the year 1911, have been as follows:— 1911, 1.6; 1912, 1.1; 1913, 1.14; 1914, 1.03; 1915, 0.83; 1916, 0.56; 1917, 0.66; and 1918, 0.32.

A preventive vaccine against Epidemic Influenza has, unfortunately, not been discovered as yet.

I have the honour to be,

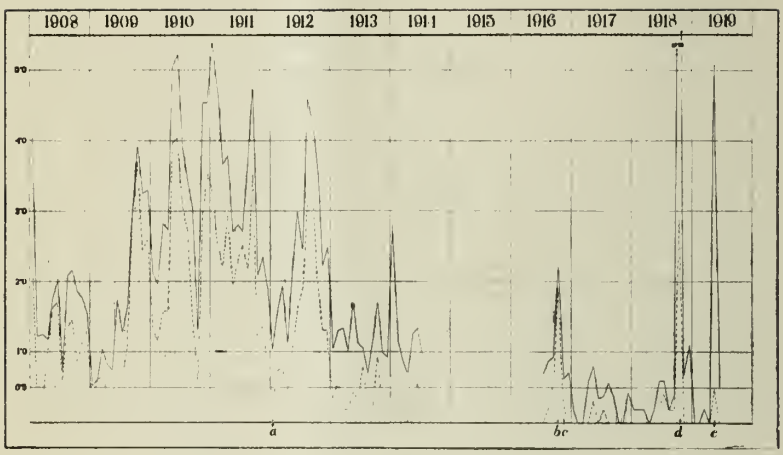
Gentlemen,

Your obedient servant,

W. WATKINS-PITCHFORD, M.D.,

Director.

Chart II.



Monthly Death-rates (per 1,000 employed) amongst Native Labourers on the Premier Mine from All Diseases (continuous line) and Pneumonia (dotted line).

Notes.

(*a*) Inoculation of every second new-arrival with Sir Almroth Wright's vaccine began January 21. Inoculation was gradually extended to all arrivals, and was continued systematically until July, 1914, when the work of the mine ceased. Work was re-started in July, 1916, *no inoculations being carried out.*

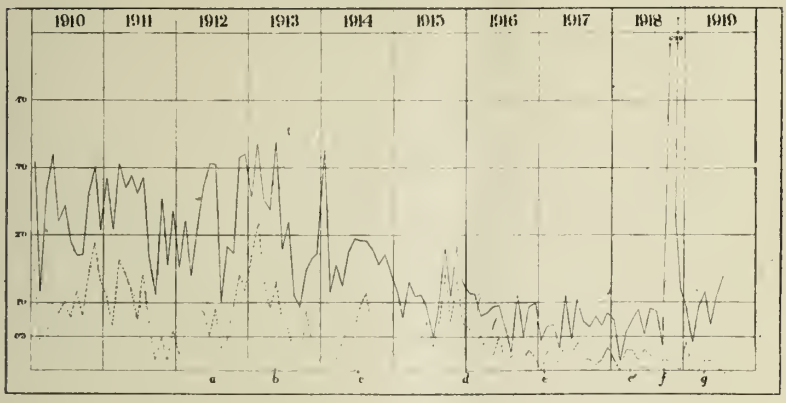
(*b*) An epidemic of Pneumonia asserted itself (October).

(*c*) During November every Native was inoculated twice with Lister's vaccine, and from that time onward every arrival has been inoculated thrice.

(*d*) Influenza epidemic.

(*e*) Recrudescence of Influenza.

Chart III.



Monthly Death-rate (per 1,000 employed) amongst Native Labourers on the Crown Mines from All Diseases (continuous line) and from Pneumonia (dotted line).

Notes.

(*a*) A large number of "Tropical" Natives were inoculated during this year by Sir Almroth Wright.

(*b*) May, 1913. Approximately three-fifths of the Portuguese East African Natives and British Basutos, *resident on the mine*, were inoculated with Sir Almroth Wright's vaccine.

(*c*) In July and the three following months *every alternate new arrival* was inoculated once with 5-group vaccine (Lister).

(*d*) Beginning in October, 1915, throughout the year 1916 and the month of January, 1917, the whole Native labour force was systematically inoculated with 5-group vaccine (Lister).

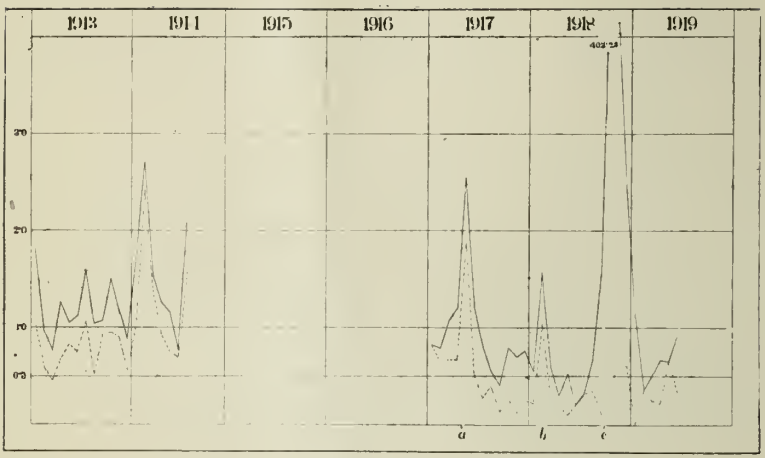
(*e*) The "experimental period" described in Publication No. X. of the Institute commenced on February 1 and lasted until October 31 1917. All new arrivals were inoculated three times with 3-group vaccine (Lister).

(*e*[1]) From April, 1918, to the present date, all new arrivals were inoculated three times with 8-group vaccine (Lister).

(*f*) Epidemic Influenza appeared (September 22).

(*g*) Recrudescence of Influenza.

Chart IV.



Monthly Death-rate (per 1,000 employed) amongst Native Labourers on De Beers Mines from All Diseases (continuous line) and from Pneumonia (dotted line).

Notes.

The work of the mines was more or less completely interrupted, owing to the war, between July, 1914, and January, 1917.

(*a*) On May 1, 1917, the inoculation of *all new arrivals* with a 4-group pneumococcal vaccine (Lister's) was initiated, those labourers already on the mines being left uninoculated. The system of inoculating all new arrivals has remained in force ever since; an 8-group vaccine replaced the 4-group from April, 1918, onward.

(*b*) A small epidemic of a disease diagnosed as "Pneumonia" by the Medical Officer of the mines occurred; that this epidemic was actually one of Pneumonia could not be confirmed by the Institute.

(*c*) September 23. Epidemic Influenza appeared.

References.

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(2) Publication No. II. of the South African Institute for Medical Research, Etiology, Manifestations, and Prevention of Pneumonia amongst Natives on the Rand. G. D. Maynard, November 1, 1913.

(3) Publication No. III. of the South African Institute for Medical Research. Specific Serological Reactions with Pneumococci from different Sources. F. S. Lister, December 22, 1913.

(4) Publication No. VIII. of the South African Institute for Medical Research. Experimental Study of Prophylactic Inoculation. F. S. Lister, Oct. 1, 1916.

(5) Publication No. X. of the South African Institute for Medical Research. Prophylactic Inoculation of Man against Pneumococcal Infections. F. S. Lister, November 10, 1917.

(6) Monographs of the Rockfeller Institute, No. 7, Acute Lobar Pneumonia.

(7) Medical Journal of Australia, May 3, 1919.

(8) *Journal of Experimental Medicine*, Vol. XXVIII., No. 19, 1918.

(9) *Journal of Experimental Medicine*, Vol. XXIX., No. 5, 1919.

(10) *Journal of Experimental Medicine*, Vol. XXVI., No. 4, 1917.

(11) Osler and McCrae, System of Medicine, Vol. II., p. 554.